Addition of Pineapple Waste in the Diets of Red Hybrid Tilapia (*Oreochromis mossambicus X Oreochromis niloticus*): Effect on Growth Performance and Survivability.

By

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A report submitted in fulfilment of the requirements for the degree of Bachelor of Applied Science (Animal Husbandry Science) with honours

Faculty of Agro Based Industry

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DECLARATION

I hereby declare that the work embodied in this Report is the result of the original research and has not been submitted for a higher degree to any universities or institutions.

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I certify that the Report of this final year project entitled "Addition of Pineapple Waste in the Diets of Red Hybrid Tilapia (*Oreochromis mossambicus X Oreochromis niloticus*): Effect on Growth Performance and Survivability" by Zuraini Binti Zainalabidin, matric number F14A0421 has been examined and all the correction recommended by examiners have been done for the degree of Bachelor of Applied Science (Animal Husbandry Science) with Honours,

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Addition of Pineapple Waste in the Diets of Red Hybrid Tilapia (*Oreochromis mossambicus X Oreochromis niloticus*): Effect on Growth Performance and Survivability.

ABSTRACT

Tilapia is one of the essential aquaculture species that produced as food sources in Malaysia. The most common tilapia found in Malaysia is red hybrid tilapia, which is the hybrid of *Oreochromis mossambicus* and *Oreochromis niloticus*. Red hybrid tilapia was recognised because of its top growth rate and high diseases resistances. These species requires good quality of feed because feed influences the growth and survivability of tilapia. However, the high cost of production inputs is mainly on feed is a significant drawback for the farmer to culture tilapia. Therefore, this research was conducted to evaluate the effect of pineapple waste supplement in the diet of juvenile tilapia to improve their growth performance and survivability. This study was conducted in six weeks. Red hybrid tilapia were fed with four different percentage of pineapple waste namely as Control = 0 % of pineapple waste + commercial feed, T1 = commercial feed + 10 % of pineapple waste, T2 = commercial feed + 30 % pineapple waste and T3 = commercial feed + 50 % pineapple waste. The growth performance was evaluated based on growth rate and feed conversion ratio, and the survivability of the fish. Red hybrid tilapia were fed with 30 % of pineapple waste in T2 were resulted 29.00 g per fish of weight gain, 1.51 % per day of specific growth rate, 0.21 of feed conversion ratio and 91.11 % of survival rate after six weeks of feeding trial. Furthermore, the growth performance of red hybrid tilapia in T2 had the lowest feed conversion ratio with the higher weight gain. This research proves pineapple waste helps to increase the nutritional value in feed that can trigger the growth of red hybrid tilapia and provide tilapia farmer with an economical feed additive from pineapple by-product.

Keywords: Red Hybrid Tilapia, Pineapple Waste, Growth Performance, survivability, diet.

Penambahan Sisa Nanas di Dalam Diet Tilapia Hibrid Merah (*Oreochromis mossambicus x Oreochromis niloticus*): Kesan ke atas Prestasi Tumbesaran dan Kemandirian

ABSTRAK

Tilapia adalah salah satu spesies akuakultur penting, yang dihasilkan untuk sumber makanan di Malaysia. Tilapia yang kebiasaannya ditemui di Malaysia adalah tilapia hibrid merah, iaitu hibrid dari *Oreochromis mossambicus* dan *Oreochromis niloticus*. Tilapia hibrid merah diiktiraf kerana kadar pertumbuhan yang tinggi dan tinggi rintangan penyakit. Spesies ini memerlukan kualiti makanan yang baik kerana makanan mempengaruhi tumbesaran dan kelangsungan hidup tilapia. Walau bagaimanapun, kos pengeluaran yang tinggi, terutamanya pada makanan adalah kelemahan utama bagi penternak untuk mengusahakan peternakan ikan tilapia. Oleh itu, kajian ini dijalankan untuk menilai kesan penambahan sisa nanas di dalam diet untuk meningkatkan prestasi tumbesaran dan kadar hidup tilapia juvenil. Kajian ini dijalankan dalam tempoh enam minggu dan tilapia hibrid merah diberi empat rawatan sisa nanas iaitu Kawalan = makanan komersial + 0% sisa nanas, T1 = makanan komersial + 10% sisa nanas, T2 = makanan komersial + 30% sisa nanas dan T3 = makanan komersial + 50% sisa nanas. Prestasi tumbesaran tilapia hibrid merah dinilai berdasarkan kadar tumbesaran dan nisbah penukaran makanan dan kadar hidup. Tilapia hibrid merah yang diberi makan dengan 30 % sisa nanas didalam T2 menghasilkan penambahan berat 29.00 g per ikan, 1.51 % per hari kadar tumbesaran khusus, 0.21 nisbah penukaran makanan dan mempunyai 91.11 % kadar hidup selepas enam minggu percubaan makanan. Selain itu, tilapia hibrid merah dari T2 mempunyai nisbah penukaran makanan yang paling rendah dengan penambahan berat yang tertinggi. Penyelidikan ini membuktikan bahawa sisa nanas dapat meningkatkan nilai nutrisi didalam makanan ikan yang dapat mengalakkan tumbesaran tilapia hybrid merah dan menghasilkan makanan tambahan yang ekonomik dari produk sampingan nanas kepada penternak tilapia.

Kata kunci: tilapia hibrid merah, sisa nanas, tumbesaran, kemandirian, diet.

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LIST OF ABBEREVIATIONS

DOF	Department of Fisheries
FAO	Food and Agriculture Organization
EU	European Union
AA	Ascorbic Acid
DO	Dissolved Oxygen
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
SGR	Specific Growth Rate
FCR	Feed Conversion Ratio
SR	Survival Rate
WG	Weight Gain
MWG	Mean Weight Gain

LIST OF SYMBOLS

g	Gram
mg/L	Milligram per litre
mg	Milligram
mm	Millimetre
cm	Centimetre
L	Litre
LU	Logical Unit
%	Percentages
℃	Degree Celsius
ppt	Part per thousand
N	Number of week
T	Experimental period in days

CHAPTER 1

INTRODUCTION

1.1 Research Background

Red hybrid tilapia, *Oreochromis mossambicus* X *Oreochromis niloticus* is one of the dominant cultured species in aquaculture production of tilapias. Tilapia is one of the world most important food fishes that gained strong demands as premium fillet in the US and increasingly requested in the EU and the Middle East (Hashim, 2015). It was first introduced into Malaysia in the 1980s. In Malaysia, the production of 34,500 metric tons was recorded in the year 2016, and the Malaysia Department of Fisheries (DOF) is targeting 60,000 metric tons by the year 2020 (Bevitt, 2016).

Pineapple or *Ananas comosus* can produce more significant quantity of waste during the processing in pineapple industries. Pineapple contains several of a nutrient such as calcium, crude fibre, vitamin C, carbohydrate, potassium, water and other minerals that are needed for a healthy digestive system and help to maintain the ideal weight and balanced nutrition.

Furthermore pineapple waste consists of pineapple peels and pineapple core. According to Pardo, Cassellis, Escobedo, and Garcia (2014), pineapple peels has higher nutritional content then edible part because it has high of dietary fibre and protein. Besides that, pineapple fruits consist of high moisture content, high sugar, high dissolved solid content of ascorbic acids and low crude fibre. According to

Hossain et al., (2015), to every 100 gram of pineapple waste, it contains 26.5 mg of ascorbic acid (AA) and every 100 gram of pineapple pulp it contains 21.5 mg of ascorbic acid. So, the vitamin C hold in pineapple waste is higher than pineapple pulp

Vitamin C is essential for the natural growth, health, general metabolism and reproduction of fish but in the small amount. Fish are unable to produce vitamin C due to the lack of enzyme L-gulonolactone oxidase and depends on exogenous supply through the dietary source (Shiau & Lin, 2006). The normal growth of *O. aureus* required 50 mg of vitamin C in their diet (Stickney et al., 1984).

However, the high cost of production inputs is mainly on feed is a significant drawback for the farmer to culture tilapia. This study is about the effect of addition pineapple waste in diets of red hybrid tilapia on growth performance and survivability and also to access its potential as the booster for tilapia against infection. The aims of this study are to enhance the tilapia growth and survivability through dietary strategy.

1.2 Problem Statement

Tilapia is one of the aquaculture species that was produced in Malaysia. Tilapia is recognised and favoured by a lot of people worldwide due to its attributes. Such as its wealth of nutrients, vitamins, minerals, include substantial amounts of protein, omega-3 fatty acids, and pantothenic acid. However, the high cost of production inputs is mainly on feed is a significant drawback for the farmer to culture tilapia. According to El-Sayed (2006), the feed cost accounts approximately 50% of the operating costs in intensive culture system, the economic viability of the culture operation depends on appropriate use of feed (Tucker, Hargreaves, & Boyd, 2008). Feed supplement are substances which are added in small amount into aqua feeds and provides mechanism by which dietary deficiencies can be addresses which benefits not only in nutrition but improves the growth rate of the fish. According to Dada (2015), the costs of production are likely to be reduced, if the growth performance and feed efficiency were increased in commercial aquaculture.

Besides, the using of pineapple waste as an addition supplement can minimize the uses of chemical in aquaculture and can enhance the utilization of waste, as well as can reduce the cost production in aquaculture. Recently, some studies show the positive effect of dietary medicinal plant and feed additives on growth and feed utilization in fish and crayfish (Soosean, Marimuthu, Sudhakaran, & Xavier, 2010; Prasad & Mukthiraj, 2011). Therefore, this study aims to evaluate the effect of pineapple waste as an economic supplement to enhance the growth performance and survivability of juvenile tilapia through dietary strategy.

1.3 Hypothesis

H_O: The pineapple waste in the diet of red hybrid tilapia statistically does not affect the growth performance and survivability.

H_A: The pineapple waste in the diet of red hybrid tilapia affects the growth performance and survivability.

H_O is rejected when p-value less than 0.05 ($p<0.05$).

H_A is rejected when p-value more than 0.05 ($p>0.05$).

1.4 Objective

1. To determine the effect of pineapple waste to the diet on growth performance and survivability of red hybrid tilapia.

1.5 Scope of Study

The study was conducted in the aquaculture laboratory in University Malaysia Kelantan, Jeli Campus. The red hybrid tilapias were subjected to feed enriched with pineapple waste. Then, the growth performance and survivability of red hybrid tilapia were determined after six weeks of feeding trials.

1.6 Significance of Study

Feed is the major factor to consider in the tilapia farming to produce a good quality of tilapia. The cost of production is the main issues in tilapia farming. This production cost can be reducing if growth performance and feed efficiency are increased in tilapia culture. The important of this study is to prove the pineapple waste can help to increases the nutritional value in feed of tilapia that can trigger the growth and survivability of red hybrid tilapia and provide tilapia farmer with an economical feed supplement. The use of pineapple waste as a supplement for tilapia were increases the utilization of waste and were reduced the production of waste. Besides, this research finding also can be used as a reference in future study.

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CHAPTER 2

LITERATURE REVIEW

2.1 Tilapia

Tilapia is one of the critical species for freshwater aquaculture in worldwide because the production of this fish has been developed and accomplished for many years in various countries. Furthermore, tilapias also have attracted the attention of the consumer and have the larger of market production in Japan, the United States, the European Union, and other developed countries (Boyd, 2004). In Malaysia, tilapia was first introduced in the 1980s. In 2016, the production of tilapia was recorded is 34,500 metric tons and Malaysia Department of Fisheries in targeting 60,000 metric tons by the year 2020 (Bevitt, 2016).

Tilapia was belonged to Cichlidae family, and has been introduced into tropical and subtropical countries for aquaculture (Boyd, 2004). Tilapias are freshwater species that can be found in shallow streams, ponds, rivers, and lakes. Tilapia species are nest builders, for example, brood parent was guarded a fertilised eggs are defended in the nest by a brood parent (Popma & Masser, 1999). Tilapias are deep-bodied and perch-shaped fish (Popma & Masser, 1999; Boyd, 2004). Almost of tilapia species grow up much accelerated and sometimes it weight can reach several kilograms.

These species has some the intrinsic characteristics, such as rusticity and tolerance to a low level of dissolved oxygen in water (Lima et al., 2012). Tilapias also are famous because of their fast in sexually mature. The body length size for sexually mature is around 8-10 cm (Chapman, 2015). There variety of factor that can be influenced the growth rates of tilapia, such as the temperature of water, sex, additive feeding and stocking density.

In population, males tilapia is more predominant than female, and it can lead to the decrease of fertility. Besides those males tilapia is fast grow and more uniform in size than females (Chapman, 2015). Tilapias usually are herbivorous, but most species of tilapia also can be fed on bottom organisms. Some species of tilapia are significantly carnivorous with eggs and fry of other fishes (Boyd, 2004).

Nile tilapia (*Oreochromis niloticus*) is one of the first fish species to be cultured in the world (Amal & Zamri, 2011). Illustration from Egyptian tombs suggested that the Nile tilapias had been cultured more than 4,000 years ago (Balarin & Hatton, 1979; Elgendy, Moustafa, Gaafar, & Ibrahim, 2015). Tilapias have the good characteristic to farming, and this fish species has earned the title aquatic chicken. Tilapia is known as severe fish that can be tolerated with a wide range of environmental condition and also has considered being more resistant to bacterial, parasitic, fungal, and viral diseases compared to other species of cultured fish (Amal & Zamri, 2011).

There many types of tilapia such as *O. niloticus* (Nile Tilapia), *O. mossambicus* (Java Tilapia), *O. aureus* (Blue Tilapia), and *O. hornorum* (Zanzibar Tilapia) (Boyd, 2004). However, some species have been hybrid such as red hybrid tilapia, which come from between *O. mossambicus* and *O. niloticus*. The red hybrid tilapia has become popular because it can be cultured in a variety of aquaculture systems and also was accepted as protein sources (Siddiqui & Al-harbi, 1995).

Red hybrid tilapia originating in United States was first developed in the late 1970's by a commercial fish breeder *(Mike sipe)* in Florida. The red hybrid tilapia (*O. mossambicus* X *O. niloticus*) is more popular among local consumer owing to its favourable characteristics like easy to culture and had wide acceptability as a protein source (Zonneveld & Fadholi, 1991; Siddiqui & Al-hardi, 1995).

The red hybrid tilapias are among tilapias that were considered as low-cost source of a protein generally in Asian countries. Due to its particular colour resembling the premium marine species such as sea bream (*Chrysophrys major*) and red snapper (*Lutjanus campechanus*), the needs for this species has been increasing speedily (Watanabe, Ernst, Olla, & Wibklund, 1989; Watanabe, Benetti, Feeley, Davis, & Phelps, 2004).

Tilapias are essential species in a local fish population that have higher market value and fish flesh characteristic that is essential in the market. The colour of flesh tilapia commonly found in light grey to white, but there few dark or red colour of muscle tissues that accumulate along the lateral line. Tilapia meat can be darker in tone due to his red muscle. The darker shade of tilapia meat and black peritoneal lining should be eradicated to prevent consumer complaints (Boyd, 2004).

2.2 Water Quality Parameter for Tilapia

Tilapia most commonly farmed freshwater fish that are tolerant high water salinity, high water temperature, pH, low dissolved oxygen, and high ammonia concentrations. All tilapias can be tolerant to brackish water. The salinity of tilapia to grow well is from 0 to 29 ppt (Chapman, 2015). But sometimes, salinity can be different depending on the species and condition of the water. Blue tilapia can grow well in brackish water that has less than 20 ppt salinity, and the Mozambique tilapia can grow well in water that has near or full strength of seawater. Reproduction of some species tilapia can occur in salinities up to 10 to 15 ppt, and it does perform well at salinities below 5 ppt (Chapman, 2015).

Tilapia is highly sensitive toward fluctuation water temperature, especially low water temperature. The optimum water temperature for tilapia growth generally is 28℃ to 32℃ (Teichert-Coddington, Popma, & Lovshin, 1997; Drummond, Murgas, & Vicentini, 2009). Tilapia was stop feeding when water temperature less than 16 or 17℃ and temperature below 10 to 11℃ is lethal (Boyd, 2004). Reproductions of tilapia are best at water temperature higher than 26℃, and there no reproduction of tilapia does occur when water temperature lower is than 20℃. In subtropical regions, the number of reproduction fry is low when daily water temperature average less than 23℃ (Boyd, 2004).

Other than that, water temperature that more than 31℃ were predisposed tilapia to the outbreak of *Streptococcus agalactiae* infection (Evan, Pasnik, Klesius, & Shoemaker, 2006; Amal et al., 2008). In other research, stated that Nile tilapia fingerling with the average weight 19.0 g is more suitable to be cultured in water temperature around 25 - 30℃ for optimum growth performance and survival rate (El-Sherif & El-Feky 2009a).

Tilapia can survive regular dawn concentration of dissolved oxygen (DO) is less than 0.3 mg/L, considerably below the limits of tolerance for most other cultured fish (Popma & Masser, 1999). The study by Amal & Zamri (2011), also had openly supported the fact in their review which is metabolism, growth, and disease resistance of tilapia was suppressed when the concentration of DO decease below from this level. It is worth to mention that, the growth of tilapia can be reached an optimum state when being provided with a concentration of dissolved oxygen that exceeds 3.0 mg/L (Chapman, 2015). On the other hand, a different case had dissented the statement when there is no further improvement of tilapia growth when the additional aeration can keep the concentration of dissolved oxygen higher up 2.0 to 2.5 mg/L.

Tilapia can survive in a range of pH, from 5 to 10, but according to Delong, Losordo and Rakocy (2009), tilapia can growth best at pH 6 to 9. Besides that, Popma & Masser (1999) was supported the fact that tilapia can sustain growth optimally in a pH range of 6 to 9. Furthermore, lower pH level of water can cause to changes of behavioural, damage a gill epithelial cell, decreased in the efficiency of the nitrogenous excretion and enhanced mortality (Amal & Zamri, 2011).

Prolonged exposed of fingerling and adults tilapia to pH 2 - 3 can show rapid swimming and opercula movement, as well as lack of body position and it can cause mortality within one to three days (Wangead, Greater, & Tansakul 1988; Amal, & Zamri 2011). Other than that, fingerling of Nile tilapia with 19.0 g of initial weight is more suitable to be cultured at water pH level 7 - 8 to get the optimum growth performance and survival rate (El-Sherif & El-Feky, 2009b).

Ammonia (NH_3) existed in two form in the tank environment, unionised (NH_3) and ionised (NH_4), the unionised ammonia is highly toxic than ionised ammonia (Delong, Losordo & Rakocy 2009). Considerable mortality of tilapia can happen within a few days after fish are abruptly transferred to water that had unionised ammonia concentrations greater than 2 mg/L. Exposure for an great enormous of time to a concentration of unionised ammonia that had greater than 1 mg/L can cause losses, especially among fry and juvenile tilapia.

Therefore, to obtain the optimum growth of tilapia, the ammonia concentration in water should be in a range 0.5 - 1 mg/L (Chapman, 2015). According to Ahmad, El-Serafy, El-Shafey, and Abdel-Hamid, (1992); El-Sayed, (2006), the number of red blood cells of nile tilapia were decreasing when prolonged exposure to ammonia, and it also can cause haemolytic anaemia and reduction of blood oxygen content.

Tilapia is a type of fish that suitable for warm water aquaculture. Besides, those tilapias are well spawned and had a wide variety of natural foods and artificial feeds. Tilapia is most commonly cultured in tropical and subtropical countries due to their tolerate in poor water quality and have lower input costs (Popma & Masser, 1999; Altun,Tekelioglu, & Danabas, 2006).

2.3 Feed

Fish required energy and essential nutrients for growth, maintenance, movement and normal metabolic functions. This can be obtained from the microorganism in ponds or combination between artificial feed and microorganism. Feed requirement of fish is based on their feeding behaviour, a physiological structure of the digestive system, size and reproductive stages (Gonzalez & Allan, 2007).

The significant components of feed contain moisture, protein, lipid, carbohydrate, mineral and vitamins. Tilapia feed can be produced from dietary additive, fish, plant and meat sources. According to Fitzsimmons (1997); Abdel-Tawwab and Ahmad (2009), the crude protein level in tilapia feed should be decreased as increasing in fish weight. Percentages of crude protein based on fish size were presented in Table 2.1.

Table 2.1. Percentage of crude protein in tilapia feed.

Fish sizes (g)	The percentage of crude protein (%)
< 0.02 g	45 - 50 %
0.02 - 2 g	40 %
2.0 - 35.0 g	35 %
≥ 35 g	30 - 32 %

Source: Fitzsimmons, 1997.

After that, the content of fish meal in a feed is around 5% when crude protein had 25% or less, while 6 to 8% of fish meal in the feed when crude protein had a higher content. However, in semi-intensive and intensive culture, fish meal evidently can be completely substituted with meat, bone, and blood meal in feed.

The fish with weight below than 2 g should be fed with 10% of lipid. While feed for bigger size of fish only required 6 to 8% of fats (Fitzsimmons, 1997). Besides that, carbohydrate level in feed for fish that smaller than one g should less than 22% and while for the bigger fish carbohydrate content should be between 25 to 30%. Carbohydrate can be provided from plant resources, such as rice, soybean, corn, and wheat. Besides, other feed ingredients and vegetable oil such as maize and sunflower oil able to provide lipid that required by fish.

Mineral and vitamin are essential for the growth of fish but in the small amount. Mineral has a crucial role in the skeletal development of fish and also have an essential role in other metabolic and the functioning of enzymes (Gonzalez & Allan, 2007). Meanwhile, the vitamin is too crucial for natural growth, health, general metabolism and reproduction.

Fish feed has a variety of sizes that can be accessed from fine crumble to large pellets. The size of a fish alliance to diameter of pellet. The appropriate sizes of the pellets should be at least in the range of 20-30% of the mouth gap of the fish. The failure of following the proportion will lead to the inefficacy of feeding due to the excessive energy required for pellet browsing. On the other hand, the vast sizes of the pellet will lower the feeding and also can cause choking. So, sizes of the pellet are important to ensure efficient feed intake. Recommended for pellet sizes for tilapia were presented in Table 2.2.

Table 2.2. Recommended pellet sizes for tilapia.

Fish size (g)	Pellet Diameter (mm)
0.5-1.0	0.5-1.5
1.0-30	1-2
30-120	2
120-250	3
> 250	4

Source: Goddard, 1996.

The accurate delivery of food is essential to reduce feed waste during feeding. Besides that, the failure of fish production is occurs when a farmer was practice the underfeeding in a fish tank while feed wastage is happening when overfeeding of fish. This problem can cause water quality deterioration (Goddard, 1996). Recommended stocking density and feeding rate for different size of tilapia in tank and estimated growth rate was presented in Table 2.3

Table 2.3. Recommended stocking and feeding rates for different size groups of tilapia in tanks and estimated growth rates.

Stocking rate (number/m^3)	Weight (grams)		Growth rate (g/day)	Growth period (days)	Feeding rate (%)
	Initial	Final			
8,000	0.02	0.5-1	-	30	20-15
3,200	0.5-1	5	-	30	15-10
1,600	5	20	0.5	30	10-7
1,000	20	50	1.0	30	7-4
500	50	100	1.5	30	4-3.5
200	100	250	2.5	50	3.5-1.5
100	250	450	3.0	70	1.5-1.0

Source: Rakocy, 1989.

2.4 Vitamin C

Vitamin C or ascorbic acid is a biological reducing agent for hydrogen transport. It is involved in many enzyme systems for hydroxylation. It also is required for the formation of collagen and normal cartilage (Shiau & Lin, 2006). According to Hossain, Akhtar, and Anwar, (2015), vitamin C is the first water-soluble antioxidant, against free radical that attack and also damage normal cell.

Pineapple is one of the tropical fruits that offering an excellent source of vitamin C. According to Hossain et al., (2015), to every 100 gram of pineapple waste, it contains 26.5 mg of ascorbic acid (AA) and every 100 gram of pineapple pulp it contains 21.5 mg of ascorbic acid. So, the vitamin C hold in pineapple waste is higher than pineapple pulp.

Ascorbic acid (AA) also play an important role in iron metabolism. Several studies have suggested the vital role of vitamin C in iron absorption. According to Bienfait and Van de Briel (1980); Fuxia, Charles, Theodore, Ross, and Raymond (2008), proved mobilisation of iron through in vitro incubation with ferritin where vitamin C served as reducing agent.

Ascorbic acids were proven to possess the ability to increases the availability of storage iron to chelators. Rendering the fact that vitamin C can upregulate ferritin, it is possible to enhance the ferritin level by vitamin C-rich food and hence increase the immune defence. During pregnancy, vitamin C can slow down the development of infection at urinary tract and reduce the possibility to get colon, oesophagus and stomach cancers (Debnath, Dey, Chanda, & Bhakta, 2012).

Fish are unable to produce vitamin C due to the lack of enzyme L-gulonolactone oxidase (Wilson, 1973; Shiau & Lin, 2006). This enzyme was responsible for the synthesis of ascorbic acids. Therefore tilapia depends on exogenous supply through the dietary source (Shiau & Lin, 2006). The normal growth of *Oreochromis aureus* required 50 mg AA/kg of vitamin C in their diet (Stickney et al., 1984; Lim, Yildirim-Aksoy, Welker, Klesius, & Li, 2010). Besides, to obtain maximum growth of juvenile *O. niloticus* x O. *aureus* required 79 mg AA/kg of vitamin C in their diet (Shiau & Jan, 1992; Sweilum, 2005). Soliman, Jauncey, and Roberts, (1994); Shiau and Lin, (2006), recommended that, *O. niloticus* require 420 mg AA/kg of vitamin C.

2.5 Pineapple

Cultivated pineapple, which called *Ananas comosus* is belonged to family *Bromeliaceae.* The ancestry of pineapple is from South America, Europeans found it in 1493. Nowadays pineapple can be found growing around the world. Pineapple is a perennial monocotyledonous plant that adopts terminal inflorescence and terminal, numerous fruits.

Pineapple or *A. comosus* is considered as the crucial commercial fruits in the worldwide (Hossain et al., 2015). The pineapple was produced in many tropical regions, where rainfall is adequate, and most are consumed locally. The primary producer of pineapple in the world is Thailand, Philippines, Brazil and China. It contributed approximately 50% of the entire output (Medina & Garcia, 2005).

Besides that, there more producers include India, Kenya, Nigeria, Mexico, Costa Rica, Indonesia, and these countries contribute roughly of the remaining fruit (Medina

& Garcia, 2005). According to Upadhyay, Lama, and Tawata, (2010), the area of pineapple plantation was nearly 9, 20,349 ha with an estimation of production is more than 18 million tons.

Pineapple can be consumed or served fresh, cooked, juiced and can be preserved (Hossain et al., 2015). Pineapple contains various of a nutrient such as calcium, crude fibre, vitamin C, carbohydrate, potassium, water and other minerals that is needed for a healthy digestive system and help to maintain the ideal weight and balanced nutrition. Pineapple encompasses a variety of nutrients that was required, such as protein, carbohydrate, vitamin and minerals.

Pineapple is an excellent source of vitamin C, and it can be a useful antioxidant that can help the absorption of iron. It's also can be used to fight bacterial and viral infections (Hossain et al., 2015). Half cups of pineapple juices can supply 50% of vitamin C that was daily recommended for the adult. Other than that, pineapple is an excellent source of the trace mineral such as manganese, which is a central stimulant for some enzymes that was influential in the production of energy and antioxidant defences (Joy, 2010). The list of nutrient in pineapple was presented in Table 2.4.

Table 2.4. Nutrients in 100 grams (g) pineapple.

Nutrients	Amount
Energy	52 calories
Dietary fiber	1.40 g
Carbohydrate	13.7 g
Protein	0.54 g
Iron	0.28 mg
Magnesium	12 mg
Calcium	16 mg
Potassium	150 mg
Phosphorus	11 mg
Zinc	0.10 mg
Vitamin A	130 LU
Vitamin C	24 mg

Source: Joy, 2010.

Besides that, pineapple fruits consist of high moisture content, high sugar, high dissolved solid content of ascorbic acids and low crude fibre. The pineapple fruits are commonly consumed in the fresh or fresh juices and also may be consumed in cans, and can be found in a broad array of foodstuffs (Debnath et al., 2012). In Panama pineapple was served in various ways such as cooked in pies, cakes, in salads or made into sauces or as preserves. While Malayans, was commonly apply the pineapple in curries and diverse of meat dishes (Hossain et al., 2015).

Moreover, pineapple also can be as additive nutritional fruits for excellent personal health. One marvellous of ripe pineapple fruit can provide a 16.2% of vitamin C daily needs (Hemalatha & Anbuselvi, 2013). It also reacts as effective antioxidant and was the consequence the formation of collagen in bones, cartilage, blood vessels, and muscle (Hossain et al., 2015).

Consume vast amount of pineapple might cause diabetes because the immense amount of pineapple consists of high sugar level. Besides that, it also can affect skin and lips due to overeating (Ramulu & Rao, 2003). When unripe, the pineapple is not suitable to eat because it was poisonous and irritating the throat.

Other than that, over-consumption of pineapple core can lead the forming of fibre balls in the digestive tract (Joy, 2010). The fruit acid in pineapple can have an aggressive, corrosive effect on gums and tooth enamel and it can bring gingivitis and cavities (Debnath et al., 2012).

2.5.1 Pineapple waste

Fruit processing industries generate a significant amount of waste during processing, and its disposal is a big problem that can lead to pollution, this issue can be defeated by utilisation of waste. Waste can be utilised by using biotechnological processes. For example, the older study was taken up of utilising the industrial waste from mango processing unit by investigating the possibility of growing a few blue-green algae on the waste and subsequently using the biomass as a source of feed to aquaculture (Sunita & Rao, 2003).

Pineapple by-product is consisting of remaining pulp, peels, stem and leaves. It generates a large quantity of waste during the processing in pineapple industries. Pineapple waste consists of pineapple peels and core (Buckle, 1989; Makinde, Odeyinka, & Ayandiran, 2011). The pineapple peel has a higher nutritional content the edible part because it has high of dietary fibre and protein (Pardo et al., 2014). The increasing production of pineapple can be the outcome in a large waste generated (Upadhyay et al., 2010).

Table 2.5. Physical and chemical constituents of pineapple pulp and waste.

Parameters	Pineapple pulp	Pineapple waste
Moisture (%)	87.3	91.35
Ash content (mg/100g)	1.8	0.04
Total soluble solids (%)	13.3	10.2
Crube fibre (g/100g-fw)	0.41	0.60
Total sugar (%)	8.66	9.75
Reducing sugars (%)	10.5	8.2
Non-reducing sugars (%)	7.4	8.8
Titratable acidity (%)	2.03	1.86
Ascorbic acid (mg/100g)	21.5	26.5

Source: Hemalatha & Anbuselvi, 2013.

Besides, pineapple processing can be generated a significant amount of unusable pineapple waste (Tanaka, Hilary, & Ishizaki, 1999; Upadhyay et al., 2010). According to Ban-koffi and Han, (1990), waste that having tremendous of biological oxygen demand (BOD) and chemical oxygen demand (COD) values can be discarded from 40-80% of pineapple fruits. A high level of BOD and COD in pineapple wastes can cause further frustration in the disposal process, and it can cause serious environmental problems.

To overcome this problem, the pineapple waste should be utilised, using advanced industrial processes such as extraction, fermentation, bioactive components. The waste from pineapple cannery industries have been used as the substrate for bromelain, organic acids, ethanol and also have a potential for being sources of sugars, vitamins and growth catalyst (Dacera, Babel, & Parkpian, 2009).

Furthermore, pineapple waste can be utilised in a numerous way. Such as, was using fermentation technology to produce various an organic acids especially citric, lactic, and ferulic acid (Upadhyay et al., 2010). Other than that, pineapple waste also can be the source of energy and carbon, when it constitutes of organic substances. Besides, anaerobic digestion could diminish the disposal problem.

In China, pineapple waste is being used as feed for dairy livestock. Waste was collected from the fields or the cannery industries before it was used as a feed (Sruamisri, 2007). While, in Nigeria, cattle are more preferred to fermented pineapple waste and while small ruminant was feed by pineapple waste after had a proper processing (Onwuka, Adetiloye, & Afolami, 1997; Adrizal, Heryandi, Amizar, & Mahata, 2017). Other than that, the silage can be produced from the expendable plant in the fields. It can be an alternative feed for maintaining cattle when forage is limited. By a mixture of urea, molasses and water, it enhances the nutritional value of silage (Joy, 2010).

Pineapple waste can be utilised as anti-dyeing agents. Pineapple stem can be appropriate as economical adsorbent material that can erase the basic dye such as methylene blue from solution by adsorption (Hameed, Krishni, & Sata, 2009). According to Weng, Lin, and Tzeng, (2009), leaf powder of pineapple had been used as an alternative bio-adsorption of methylene blue.

Besides that, toxic metals such as mercury, lead, cadmium, copper, zinc and nickel can be removed efficiently by biosorbent from residues of pineapple fruit (Senthilkumaar, Bharathi, Nithyanandhi, & Subburam, 2000). Other than that, the heavy metal from contaminated sewage sludge also can be abstracted by using citric acid received from fermented pineapple waste with *Aspergillus niger* (Dacera & Babel, 2008). Pineapple waste liquid also can be used as an affordable substitute of nutrients for *Acinetobacter haemolyticus,* which was used to minify the contamination of chromium VI (Zakaria, Zakaria, Surif, & Ahmad, 2007).

The high value of reusable substance from pineapple waste, such as the residue from cannery industries has immense exploitation potential with inspiriting upcoming. Moreover, dietary fibres and phenolic antioxidants can be used as a vulnerable nutraceutical resource that was capable of contributing a significant economic, nutritional dietary supplement for low-income communities (Upadhyay et al., 2010).

The uses of the pineapple waste were enrich the fish feed in order to enhance the growth performance and survivability of red hybrid tilapia. It is believed that the vitamin C-rich pineapple waste was able to elevate and boost the growth of tilapia. This study aims are to enhance the tilapia growth and survivability through dietary strategy. In this case, pineapple wastes were added to access its potential as the booster for tilapia against infection.

CHAPTER 3

MATERIALS AND METHODS

3.1 Preparation of Red Hybrid Tilapia

The tilapia fingerling of similar size 2.50 ± 0.29 g per fish was bought from a fishmonger. The total of tilapia fingerling were used in this experiment was 60 fish. The fingerling is allowed to acclimatise them before transferring into separate tanks. The fingerling was placed in the tanks equipped with aeration. The water parameter that was used is standard for rearing the fingerling of tilapia. Fish were fed twice daily with a commercial diet devoid of vitamin C (the amount of feed at 3% of the body weight).

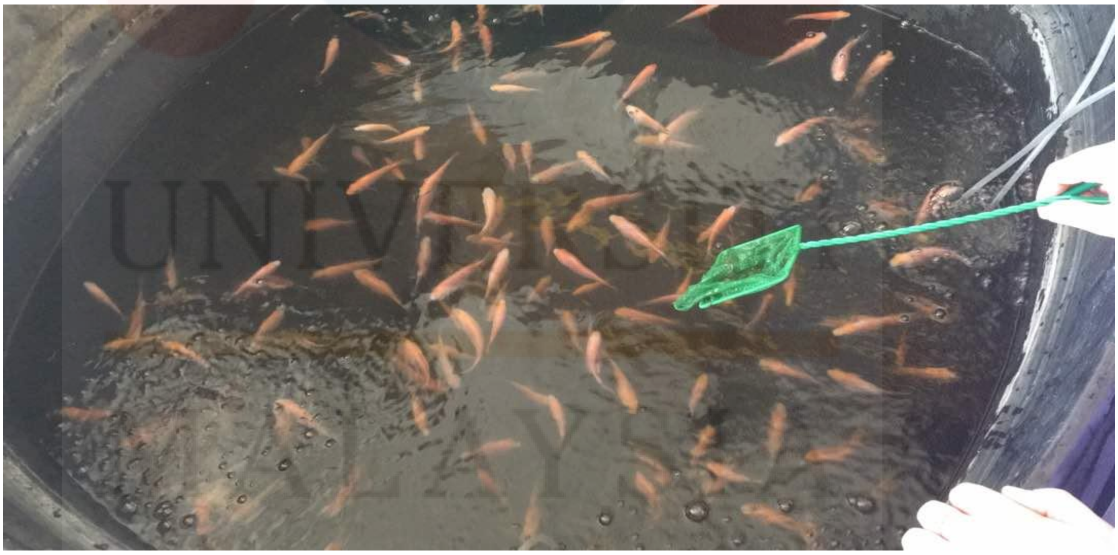

Figure 3.1: The tilapias are allowed to acclimatise in the tanks equipped with aeration.

The tilapia was allowed two weeks for acclimatisation to the new environment. Fish were starved for 24 hours before the commencement of the feeding trial and not fed on a weighing day. The aquarium was cleaned twice in weeks to prevent any infection from the pathogen.

3.2 Preparation of Pineapple Waste Sample

For this experiment pineapple were bought from the wet market around Jeli, Kelantan. The pineapple was cleaned to get off the dirt. Skin was peeled, and the core was separated from the flesh. In this experiment, the skin and core were used. The wastes were weighted using the weighing scale. Then, the pineapple waste was milled by using electric blender into a pineapple waste paste. The paste was filtered using the muslin cloth and subsequently using filter paper to get the liquid sample of pineapple waste.

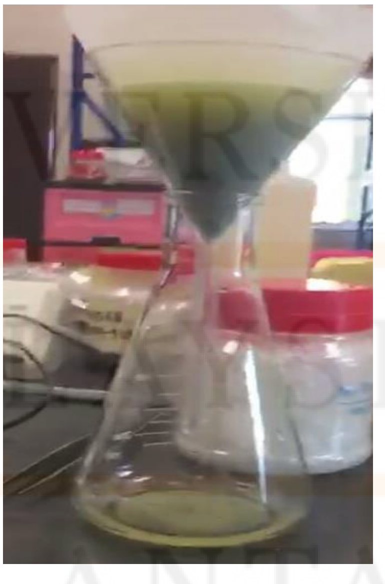

Figure 3.2: The liquid sample of pineapple waste was filtered using filter paper.

3.3 Water Quality Requirement

Tilapias are most commonly farmed freshwater fish that had tolerant with high water temperature, pH, and low dissolved oxygen (DO). All tilapia are tolerant to brackish water, and tilapia hybrid descended from *Oreochromis massambicus* origin is believed to be highly tolerant to saline waters (Romana-Eguia & Eguia, 1999). Freshwater conditions were monitored using YSI Pro Plus Water Quality Meter.

Table 3.1: Water quality parameter.

Water quality parameter	Standard
Temperature (℃)	25 – 30
pH	7 – 8
Dissolved oxygen (DO) (mg L^{-1}	7.1 - 8.1

3.4 Preparation of Feed

The feed was purchased from feed store around Jeli, Kelantan. The commercial feed containing 30% of crude protein, 4% of crude lipid, 6 % of crude fibre and 12% of moisture was selected. The commercial feed was mixed with 10%, 30% and 50% of volume pineapple waste per weight of feed.

Table 3.2: Percentages of pineapple waste that mixed with commercial feed.

Treatment	Feed proportion
Control	100 % of commercial feed + 0 % of pineapple waste
Treatment 1	90 % of commercial feed + 10 % of pineapple waste
Treatment 2	70 % of commercial feed + 30 % of pineapple waste
Treatment 3	50 % of commercial feed + 50 % of pineapple waste

3.5 Feeding Trials

Four aquariums (30 litre aquarium) per diet were prepared and stocked with 15 fingerlings each. Fish were fed twice daily at 3 % body weight for six weeks (Pretto-Glordano, Muller, Freitas & Silva, 2010).

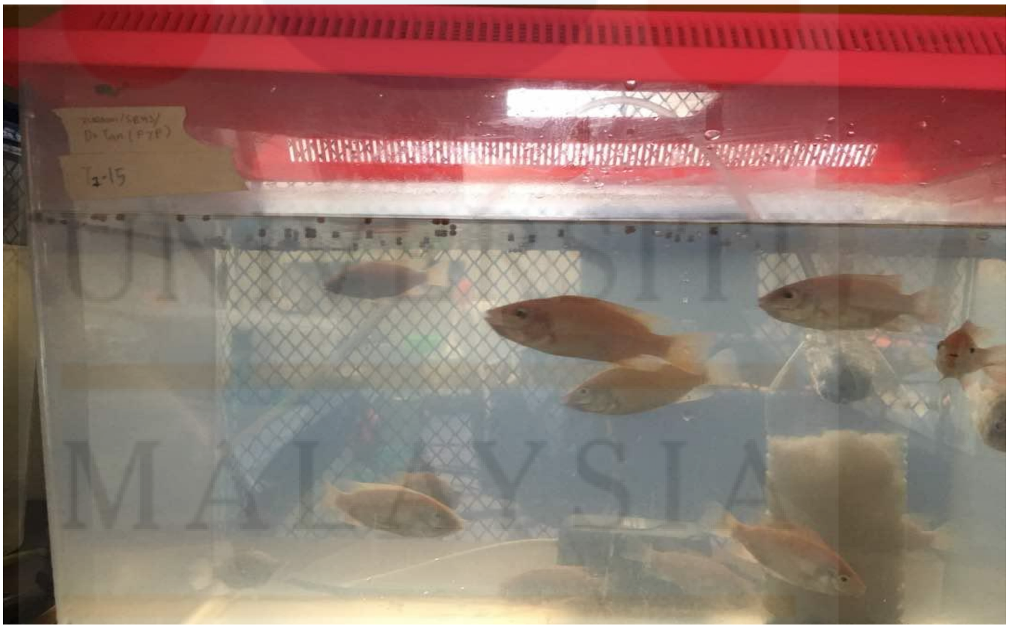

Figure 3.3: Fish were fed twice daily for six weeks.

3.6 Fish Sampling

The fish sampling was done by randomly taken five fingerlings from each tank to measure the growth rate in every week (Adewole, 2014).

3.7 Analysis of growth performance and survivability

At the end of the feeding trial, the weight gain, specific growth rate, feed conversion ratio, and survival rate were individually calculated by the following equation.

3.7.1 Weight Gain

Weight Gain: the total and mean weight gain was calculated for each treatment as follow:

Weight Gain/Fish (WG) (g/fish) = (Wf – Wi)

Where,

Wf = The final weight of fish at the end of the experiment.

Wi = The initial weight of fish at the beginning of the experiment.

3.7.2 Specific Growth Rate (SGR)

Specific growth rate (SGR) (%/day) = $\left(\frac{(\log Wf - \log Wi)}{T}\right) \times 100$

Where,

log Wf = Logarithm of the final fish weight

log Wi = Logarithm of the initial fish weight

T = Experimental period of days

3.7.3 Feed conversion ratio (FCR)

Feed conversion ratio (FCR) = $\frac{\text{feed intake (g)}}{\text{weight gain (g)}}$

3.7.4 Survivability

Survival rate (SR %) = $\left(\frac{Nf}{Ni} \times 100\right)$

Where,

Nf = The number of culture fish stocked at the beginning of the experiment.

Ni = The Number of culture fish alive at the end of the experiment.

3.8 Statistical analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (SSPS) software version 22. Statistical difference for the growth performance, specific growth rate, feed conversion ratio and survivability of the experimental fish (with the different percentage of pineapple waste) and the control fish were determined using One-way ANOVA and post-hoc Duncan multiple range tests at $P<0.05$.

CHAPTER 4

RESULTS & DISCUSSION

4.1 Environmental condition

Water quality parameter throughout experiment period was presented in Table 4.1.

Table 4.1: Water quality parameter through experimental period

Water quality parameter	Experimental data
Temperature (℃)	28.20 – 28.81
Ph	5.30 – 6.67
DO (mg O^2/L)	3.59 – 4.44

Based on Table 4.1, water condition thorough experimental period was suitable for rearing red hybrid tilapia fingerlings. Water temperature in this experiment ranged from 28.20 to 28.81℃. According to Drummond et al., (2009), the optimum water temperature for tilapia growth generally is 28℃ to 32℃. Other study by stated that tilapia fingerling with the average weight 19.0 g is more suitable to be cultured in water temperature around 25 - 30℃ for optimum growth performance and survival rate (El-Sherif & El-Feky 2009a).

Throughout the experiment, the pH value was at minimum 5.30 and maximum 6.67. It was supported by Delong et al., (2009), stated that, tilapia can survive in a range of pH, from 5 to 10, and tilapia can growth best at pH 6 to 9. During the experiment period, the dissolved oxygen (DO) ranged from 3.59 to 4.44. These was supported by Chapman (2015), the growth of tilapia can be reached an optimum state when being provided with a concentration of dissolved oxygen that exceeds 3.0 mg/L.

4.2 Effect of Pineapple Waste on Growth Performance of Red Hybrid Tilapia.

4.2.1 Weight Gain

Weight gain of red hybrid tilapia fed with different treatment diet after six weeks of feeding trial was presented in Table 4.2.

Table 4.2: Weight gain of red hybrid tilapia fed by addition of pineapple waste in diets.

Treatments	Weight Gain/fish (g/fish) (Mean ± Std. Error)
C	15.60 ± 2.68
T1	25.80 ± 4.42
T2	29.00 ± 6.28
T3	27.20 ± 4.40

*Values are mean ± Std. Error of four treatments. Values in the same column with different superscripts are significantly different ($p<0.05$).
*C: commercial feed without pineapple waste; T1: commercial feed with 10 % of pineapple waste; T2: commercial feed with 30 % of pineapple waste; T3: commercial feed with 50 % of pineapple waste.

Table 4.2 shown a weight gain per fish calculated a weight gain of red hybrid tilapia fed by addition of pineapple waste in diets for each treatment. Based on table 4.2, weight gain from Treatment 2 (T2) shown the highest weight gain with 29.00 g weight gain per fish. Followed by Treatment 3 (T3) and Treatment 1 (T1). The lowest weight gain of red hybrid tilapia was from control (C) with 15.60 g of weight gain per fish. The study demonstrated that all the treatment have no significant difference.

From these result, it could be decided that the increasing weight gain of red hybrid tilapia it occur because the rich of nutrient contains in pineapple waste. According to Hemalatha and Anbuselvi (2013), the pineapple waste was found to be higher amount of total sugar (9.75%) and non-reducing sugar (8.8%) than pineapple pulp, which is essential for growth of red hybrid tilapia fingerling and also have protein content in waste 10 mg per 100 g of pineapple waste.

Vitamin C is one of nutrient that contains pineapple waste. It was needed by fish because vitamin C is indispensable for fish. Therefore, fish only depend on exogenous supply through the dietary source to get the requirement of vitamin C. According to Buckle, (1989) and Tanaka et al., (1999), pineapple waste is a by-product of pineapple industry that can be generated in large quantities of unusable waste material which can be used as potential nutrients enriched resource for the growth of fish. Supplements ingredients such as vitamin C from pineapple waste are very essential because it can add to the diet supply for the feed of red hybrid tilapia to increase the growth rate and size.

4.2.2 Specific Growth Rate (SGR)

Specific growth rate of red hybrid tilapia fed with different treatment diet after six weeks of feeding trial was presented in Table 4.3.

Table 4.3: Specific growth rate per day of red hybrid tilapia.

Treatment	Specific growth rate (%/day) (Mean ± Std. Error)
C	0.88 ± 0.04^{a}
T1	1.42 ± 0.08^{b}
T2	1.51 ± 0.09^{b}
T3	1.52 ± 0.10^{b}

*Values are mean ± Std. Error of four treatments. Values in the same column with different superscripts are significantly different ($p<0.05$).
*C: commercial feed without pineapple waste; T1: commercial feed with 10 % of pineapple waste; T2: commercial feed with 30 % of pineapple waste; T3: commercial feed with 50 % of pineapple waste.

Based on Table 4.3, the highest specific growth rate of red hybrid tilapia is from T3 with 1.52 % per day and followed by T2 with 1.51 % per day and T1 with 1.42 % per day. The lowest of specific growth rate with of 0.88 % per day has come from C. The study demonstrated that all the treatment have a significant difference. Based on Table 4.3, the highest specific growth rate of red hybrid tilapia is from T3 with 1.52 g per fish were feed with 50 % of pineapple waste in the feed. This indicates that, T3 growth at fast rate compared with other treatment.

The specific growth rate was significantly different between control and the group of treatment. But, the specific growth rate was not significantly different within the treatment. Fish supplied by the diet devoid of pineapple waste displayed significantly poor growth rate while feed that enriches with pineapple waste exhibited significantly better growth rate. According to Olurin, Oluja, and Olukoya (2006), this study indicate that, red hybrid tilapia was fed with pineapple waste can utilize pineapple waste better than red hybrid tilapia was devoid fed with pineapple waste.

Previous study (Omoregie, Igoche, Ojobe, Absalom, & Onusiriuka, 2009) was stated that sweet potato peel supplement in diet of nile tilapia can enhance the specific growth rate of tilapia and nile tilapia could tolerate up to 15 % level of inclusion of sweet potato peel waste from other plant also can be incorporated into fish feeds in order to reduce the cost associated with production of farmed fish. The same result findings were observed in tilapia fingerlings by Adewolu, (2008), and in *Cyprinus carpio* By Faramarzi, Lashkarboloki, Kiaalvandi & Iranshahi, (2012),

4.2.3 Feed Conversion Ratio (FCR)

Feed conversion ratio of red hybrid tilapia fed with different treatment diet after six weeks of feeding trial was presented in Table 4.3.

Table 4.4: Feed conversion ratio of red hybrid tilapia fed by addition of pineapple waste in diets.

Treatment	Feed conversion ratio (Mean $\pm$ Std. Error)
C	0.35 ± 0.05^{b}
T1	0.23 ± 0.03^{ab}
T2	0.21 ± 0.02^{a}
T3	0.23 ± 0.04^{ab}

*Values are mean $\pm$ Std. Error of four treatments. Values in the same column with different superscripts are significantly different ($p<0.05$).
*C: commercial feed without pineapple waste; T1: commercial feed with 10 % of pineapple waste; T2: commercial feed with 30 % of pineapple waste; T3: commercial feed with 50 % of pineapple waste.

Based on Table 4.4, there were significantly differences ($p<0.05$) of FCR between Treatment 2 and Control. Besides, T2 had the lowest FCR of red hybrid tilapia which is 0.21 and followed by T3, T1 and C. So, from this result T2 was showed that it had the lowest of FCR with the higher weight gain then other treatment.

From this study pineapple waste played a substantial role in enhancing the growth rate and feed conversion ratio of the red hybrid tilapia. According to Hemalatha and Anbuselvi (2013), sugar contain in pineapple waste can give sweetness in the feed. Therefore it can enhance the fish to eat more without any side effect and can increases the weight of red hybrid tilapia. From previous study, the dietary supplementation of fructooligosaccharides improved daily body weight gain of animals by increasing the activities of amylase and protease (Rajinder & Tarang, 2017).

Mohd din, Razak, & Sabaratnam, (2012), studied the effect of mushroom supplementation as a prebiotic compound in super worm based diet on growth performance of red tilapia fingerlings. There was increase in SGR, FCR and PER level and survival was up to 93.33%. 10% supplementation level of MSM as a prebiotic for tilapia could be used in the insect-based diet, *Zophobas morio.*

Besides, the utilisation of mellon shell as dietary energy source in the diet of nile tilapia (Oreochromis niloticus) increases the growth (Orie & Ricketts, 2013). Mellon shell meal inclusion in the diet of Tilapia up to 75% can be effectively utilized by the Oreochromis niloticus. The specific growth rate, protein intake, protein efficiency ratio, gross feed conversion efficiency, feed efficiency, mean feed intake, survival rate, and percentage weight gain increases as the level of dietary cowpea (vigna unguiculata) hull meal increased. The replacement of maize meal by cowpea hull meal diet within 50% to 100% level enhances growth performance of C. gariepinus fry (Falaye, Omoike,& Olasebikan, 2013).

4.2.4 Survivability

Survival rate of red hybrid tilapia fed with different treatment diet after six weeks of feeding trial was presented in Table 4.5.

Table 4.5: Percentage survival rate red hybrid tilapia.

Treatment	Survival rate (SR %) (Mean $\pm$ Std. Error)
C	83.33 ± 5.90^{a}
T1	90.00 ± 4.13^{ab}
T2	91.11 ± 2.81^{ab}
T3	100.0 ± 0.00^{b}

*Values are mean $\pm$ Std. Error of four treatments. Values in the same column with different superscripts are significantly different (p<0.05).
*C: commercial feed without pineapple waste; T1: commercial feed with 10 % of pineapple waste; T2: commercial feed with 30 % of pineapple waste; T3: commercial feed with 50 % of pineapple waste.

Table 4.5 shows the highest of survivability is from T3 with 100 % of survival rate followed by T2 with 91.11 % of survival rate and T1 with 90.00 % of survival rate. The lowest survivability is from control with 83.33 % of survival rate.

The result revealed, there are significantly differences (p<0.05) of survival rate between T3 and C. T3 had 100 % of survival rate compared to other treatment and control which mean there no mortality occur during the feeding trial. This may due to acclimation of tilapia that had been practice for two weeks before feeding trial. The advantages of these practices had provided time for tilapia to adapt toward culture condition and new feed.

From observation, some of the red hybrid tilapia was cannot survived because of competitive interaction between the different size of fish (Martin et al., 2010). This situation were effected the performance and ability of fish to eat and survive.

According to Marian, Ponniah, Pitchairaj and Narayanan (1982), behaviour of growth rate significantly depend on the quantity of feed offered to fish, and by abetting water quality deterioration, the feed can cause a perverse effect on growth performance. It has been identified that overfeeding is fatal than underfeeding. Feed ration greater than optimum feed level would increase the waste food, improve the feed conversion ratio and also deteriorate water quality.

The study demonstrated that feed with commercial feed and pineapple waste played an important role in survivability of red hybrid tilapia. It is because vitamin C-rich feed that contains in pineapple waste can hence be increasing the immune defence of fish (Debnath et al., 2012). Based on the observation, the mortality rate of red hybrid tilapia is lower than 50 % because there low mortality during the feeding trial. According to Hemdal (2009), the purpose of the mortality rate is a number of deaths in a population over time. If the time span is beyond the animal's maximum lifespan, then the mortality rate would obviously be 100%. The mortality rate is necessary because if the fish died, it can affect the farmers and resulting in low production within the industry.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In conclusion, red hybrid tilapia were fed with 30 % of pineapple waste in T2 was resulted 29.00 g per fish of weight gain after six weeks of feeding trial. Besides that, red hybrid tilapia from T2 had 1.51 % per day of specific growth rate and had 0.21 of feed conversion ratio. Furthermore, T2 had 91.11 % of survival rate. From these data, suggested that T2 intensely suitable and recommended combination for growth on red hybrid tilapia (*Oreochromis massambicus* x *Oreochromis niloticus)* by considering the lower feed conversion ratio, good specific growth rate and a high survival rate.

It can be conclude that pineapple waste helps to increases the nutritional value of the feed that can trigger the growth of red hybrid tilapia. Besides that, vitamin C from pineapple is new add value that can improve the growth rate of red hybrid tilapia tremendously and its fish feed utilisation efficiencies were better than the only commercial feed feeding.

Other than that it can attract the fish to eat more without any side effect and it increases the growth performance and also can improve the survivability of the red hybrid tilapia. Overall, H_O was rejected as the pineapple waste in the diets of red hybrid tilapia does not affect the growth performance and survivability. Finally, commercial feed and 30 % of pineapple waste (T2) had been a success. As a result it can be selected to improve growth performance and survivability of red hybrid tilapia.

5.2 Recommendation

For better growth of red hybrid tilapia, more study need to enlarge. Further study that was recommended, such as infect red hybrid tilapia with *Streptococcus sp.* to determine the survivability using the addition pineapple waste in their diet. It's for identified which is pineapple waste can affect the survival rate of fish after challenging with Streptococcus *sp*. The *Streptococcus sp.* was been chosen because it is main causative agent that threat the tilapia production and it also consider as diverse bacteria that can infect wide range of host.

Pineapple waste contains a high nutritional value that can support red hybrid tilapia growth performance and survivability. Feed that has high nutritional value contains protein, lipids, carbohydrate, vitamins and minerals can give healthy and high-quality product. For enhancements, the feed must include vitamin C because vitamin C is one costly part of fish feed, it is important to accurately determine the vitamin C requirements for each species and size of cultured fish. Vitamin C levels in aquaculture feed 79 mg AA/kg for tilapia (Shiau & Lin, 2006). Last but not least, 30 % pineapple waste in Treatment 2 needs to be commercialized to the industry because the ingredients are suitable to maximize the growth of red hybrid tilapia. Action in upgrading the feed quality for red hybrid tilapia should be done to fulfil the demands of consumer, and it is the way to reduce the cost by producing the new feed.

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APPENDIX A

SSTATISTICAL ANALYSIS

Table A.1: One way ANOVA of growth performance of red hybrid tilapia.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
WeightGain	Between Groups	542.000	3	180.667	1.692	.209
	Within Groups	1708.800	16	106.800		
	Total	2250.800	19			
WeightPercent	Between Groups	.000	3	.000	.000	1.000
	Within Groups	1054.201	16	65.888		
	Total	1054.201	19			
MeanWeightGain	Between Groups	15.056	3	5.019	1.692	.209
	Within Groups	47.466	16	2.967		
	Total	62.522	19			
SGR	Between Groups	1.412	3	.471	13.310	.000
	Within Groups	.566	16	.035		
	Total	1.977	19			
FCR	Between Groups	.065	3	.022	2.524	.094
	Within Groups	.137	16	.009		
	Total	.202	19			

Table A.2: Specific growth ratio of red hybrid tilapia.

SGR

Duncan[a]

Treatment	N	Subset for alpha = 0.05	
		1	2
C	5	.8760	
T1	5		1.4220
T2	5		1.5080
T3	5		1.5200
Sig.		1.000	.447

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

Table A.3: Feed conversion ratio of red hybrid tilapia.

FCR

Duncan[a]

Treatment	N	Subset for alpha = 0.05	
		1	2
T2	5	.207540	
T1	5	.229520	.229520
T3	5	.230800	.230800
C	5		.352280
Sig.		.712	.063

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

Table A.4: One way ANOVA of survival rate of red hybrid tilapia.

ANOVA

SurvivalRate

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	844.444	3	281.481	3.141	.048
Within Groups	1792.563	20	89.628		
Total	2637.008	23			

Table A.5: Survival rate of red hybrid tilapia.

SurvivalRate

Duncan[a]

		Subset for alpha = 0.05	
Week	N	1	2
C	6	83.3333	
T1	6	90.0000	90.0000
T2	6	91.1133	91.1133
T3	6		100.0000
Sig.		.193	.098

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.